

Carleton University

Department of Mechanical and Aerospace Engineering

Graduate Webinar Series

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Characterization and Design Optimization of Periodic Cellular Solids for Optimal Bone Ingrowth in Osseointegration Implants

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Abstract

Post-operative complications of spinal lumbar fusion include cage subsidence and non-union. The lack or delayed osseointegration of the fusion cage may be one of the problems resulting in poor clinical outcomes. The use of micro-architected truss-like lattice materials to improve implant osseointegration is getting more attention beyond spinal fusion. Therefore, the main goal of this research is to define the optimal lattice microscopic parameters to maximize bone ingrowth, for fusion spinal cages. A tool based on previous mechano-regulatory models is implemented numerically, to determine the fraction of void space within a structure that receives optimal stimulation for bone ingrowth. The model was used to replicate previous *in silico* and *in vivo* results and showed very good agreement when comparing the different lattice topologies, unit cell orientation, microscopic strut cross-section shape as well as strut size. Characterization of the performance of lattice materials, relevant for osseointegration, is conducted for fourteen-unit cell topologies, with ten relative densities, under four axial loadings. Results suggested that Diamond, X-Shape, Tesseract and Rhombic Dodecahedron with horizontal orientation provide the best biomechanical environment for cells to grow and form bone tissue.

Bio

Ariane Parisien is a research assistant working with Carleton University, Aerospace Structures and Materials Engineering Laboratory. She received her M.A.Sc Degree in Biomedical Engineering at Carleton University in October 2021. She also obtained her bachelors' degree in science, specialized in human kinetics from the University of Ottawa, in 2019. Her research focuses on optimizing materials used for 3D printed orthopedics implants, for better osseointegration.